
Index

Symbols

2I-automaton, 323, 324

ε move, 105

A

A-condition for attribute evaluation, 359

Abstract syntax tree, 303, 335

Acceptance

by empty stack, 144

with final state, 148

Accepting mode of pushdown machine, 149

Accessible

state, 99, 177

subsets, 115

Acyclic attribute grammar, 345, 347

Acyclicity test, 347

Algol 60, 52

Algorithm

Berry and Sethi, 129

bottom-up parser construction, *see* *ELR(1)*
parser construction

composition of local automata, 124

conversion of translation grammar to

postfix form, 316

deterministic automaton from a regular

expression construction, 127

determinization of finite automaton, 131

Earley parser, 253

ELR(1) parser construction, 190

pointerless, 222

with vector stack, 202

finite automaton complementation, 132

finite automaton determinization, *see*

Powerset construction

from grammar to nondeterministic

pushdown automaton, 143

from regular expression to deterministic

finite automaton, *see* Berry and

Sethi algorithm

from regular expression to grammar, 67

local recognizer construction, 122

merge of kernel-equivalent m-states, 219

one-sweep evaluator construction, 349

operator precedence parallel parser
construction, 281

operator precedence sequential parser
construction, 275

pilot graph construction, 183

powerset construction, 117

predictive parser construction

as *DPDA*, 237

by recursive procedures, 238

predictive pushdown transducer

construction, 308

spontaneous move elimination, 115

syntax tree construction, 262

top-down parser construction, *see*
Predictive parser construction

topological sorting, 346

Alphabet, 7

unary, 75

Alphabetic homomorphism, 79, 298

Alternative, 18, 31

Ambiguity, 45

conditional instruction, 52, 301, 305

degree, 46

EBNF, 85

inherent, 53, 119, 160

of automaton, 111, 160

of bilateral recursion, 47

of circular derivation, 304

of concatenation, 49

of regular expression, 21, 68

of translation, 304

of union, 48

source grammar, 305

versus nondeterminism, 160

ANTLR, 242, 248

Aperiodic language, 136

Arden identity, 72

Arithmetic expression, 38, 39, 45, 48, 54, 55,
59, 85, 311

- Arithmetic expression (*cont.*)
 - calculating machine, 358
 - machine net, 167
 - parenthesis-free, 70
 - polish, 302
 - syntax chart, 169
- Artificial language, 5
- Attribute, 334, 336
 - inherited, *see* Right attribute
 - left, *see* Left attribute
 - lexical, *see* Lexical attribute
 - right, *see* Right attribute
 - synthesized, *see* Left attribute
- Attribute grammar, 335, 360
 - A-condition, 359
 - acyclic, 345
 - applications, 360
 - definition, 341
 - L* condition, 354
 - multi-sweep, 351, 367
 - one-sweep, 348
- Attribute subgrammar, 351
- Automaton
 - ambiguous, 111, 160
 - clean, 99
 - configuration, 94
 - equivalent, 95
 - finite, 96
 - finite deterministic, 97
 - for local language, 122
 - from regular expression, 119, 121
 - generalized, 113
 - local, 122
 - normalized, 123
 - minimization, 101
 - nondeterministic, 107
 - product, 134
 - to regular expression, 112
 - two-way, 331
 - unidirectional, 94
 - with spontaneous moves, 109
- Available variables, 385
- Axiom, 30, 31
- B**
 - Back-end compiler, 365
 - Base of macro-state, 183
 - Berry, 129
 - Berry and Sethi, 129
 - algorithm, 130
 - Berstel, 121, 295
 - Binary operator, 301
 - Block structure, 29
 - BMC, 112
 - BNF grammar, 31, 206
 - Bottom-up
 - attribute evaluation, 359
 - deterministic translation, 313
 - parser with attribute evaluator, 357
 - syntax analysis, 163
 - Brzozowski and McCluskey, 112
 - BS, *see* Berry and Sethi
 - BT, 261
 - BuildTree*, 261
- C**
 - Cancellation rule of Dyck, 42
 - Candidate, 174
 - identifier, 190
 - Cardinality of language, 8
 - Cartesian product of automata, 134
 - CF family, 68, 74, 78, 81, 83, 151
 - closure properties, 44
 - Choice of a regular expression, 19
 - Chomsky
 - hierarchy, 33, 86
 - normal form, 33, 61
 - Circular derivation, 36, 304
 - Clean automaton, 99, 373
 - Cleaning
 - of automaton, 99
 - of grammar, 35
 - Cleaveland, 89
 - Closing mark, 25
 - Closure
 - function, 174
 - in Earley parser, 250
 - of macro-state, 183
 - Closure properties
 - of *CF*, 44, 78
 - of *CF* and *REG*, 78
 - of *DET*, 155
 - of *REG*, 23
 - under substitution, 81
 - under translation, 332
 - under transliteration, 81
 - Code generation, 364
 - Codes and ambiguity, 50
 - Coke–Younger–Kasami algorithm, 247
 - Compaction of pilot, 218
 - Compiler
 - decomposition, 351
 - language, 334
 - Complement
 - automaton, 132
 - of language, 13
 - of regular language, 132
 - Completion in Earley parser, 251

- Computation, 94, 107, 147
 - label, 98, 107
 - length, 107
 - of nondeterministic automaton, 107
 - Concatenation, 9
 - of context-free languages, 44, 78
 - of Dyck languages, 50
 - of languages, 12
 - Condensed skeleton tree, 40
 - Conditional instruction, 52, 301, 305
 - ambiguity, 52, 301, 305
 - Configuration of an automaton, 94, 143, 147
 - Conflict
 - convergence, 182
 - reduce–reduce, 182
 - shift–reduce, 182
 - Conservative approximation, 373
 - Constant
 - folding, 383
 - propagation, 380, 383
 - Context-dependent language, 86
 - Context-free
 - deterministic, 155
 - grammar
 - definition, 31
 - from pushdown automaton, 151
 - introduction, 29
 - translation, 299
 - Context-sensitive language, 86
 - Control instruction translation, 365
 - Control-flow graph, 370, 371
 - automaton, 371
 - language, 371
 - Convergence conflict, 182, 184, 186
 - Convergent transitions, 184
 - Copy rule, 57
 - Copy-free normal form, 57
 - Cross operation, 16
- D**
- Dart, 232
 - Data-flow equations, 376, 381
 - liveness, 376
 - reaching definitions, 381
 - solution, 376
 - Dead code, 384
 - Decidable language, 95
 - Decimal constant, 96, 99, 109, 111
 - Decision algorithm, 92
 - Decompiler, 297
 - Decorated tree, 337, 339
 - Degree of operator, 301
 - Dependence graph, 339, 343, 348
 - of decorated tree, 339, 345
 - of semantic function, 343
 - Derivation, 33
 - circular, 36
 - EBNF*, 84
 - left, 41
 - of regular expression, 20
 - right, 41
 - self-nested, 74
 - DET* family, 155, 244
 - Deterministic
 - finite automaton, 97
 - language, 155
 - unambiguity, 159
 - language families comparison, 242
 - pushdown automaton, 155
 - subclasses, 160
 - simple grammar, 161
 - Determinization of automaton, 114, 130
 - Dictionary, 8
 - Difference of languages, 13
 - Digrams, 121
 - Distance of strings, 286
 - Distinctly parenthesized grammar, 43, 162
 - Distinguishability of states, 101
 - Document type definition, 162
 - Double service lemma, 158
 - DTD*, 162
 - Dyck
 - cancellation rule, 42
 - language, 42, 69, 79
 - concatenation, 50
 - Dynamic error, 364
- E**
- Earley
 - algorithm, 248, 252
 - closure, 250
 - introductory example, 249
 - nonterminal shift, 251
 - parser, 252
 - completeness, 257
 - completion algorithm, 252
 - computational complexity, 259
 - correctness, 257
 - function *BuildTree*, 262
 - grammar ambiguity, 268
 - grammar unambiguity, 260
 - nullable nonterminals, 265
 - optimization, 260
 - syntax analysis algorithm, 253
 - syntax tree construction, 261
 - syntax tree construction complexity, 266
 - terminal shift algorithm, 253

- Earley (*cont.*)
 - vector, 252
 - terminal shift, 250
 - vector, 252
 - Early scanning, 207
 - EBNF* grammar, 82, 165
 - ambiguity, 85
 - derivation, 84
 - translation, 313
 - Editing distance, 286
 - ELL*(1)
 - condition, 214
 - direct, 233
 - violation, 236
 - parser
 - direct construction, 231
 - step by step construction, 217
 - parsing, 211
 - PCFG*, 226
 - violation remedy, 246
 - ELL*(*k*)
 - condition, 240
 - parser, 242
 - ELR*(1)
 - condition, 185
 - grammar, 245
 - language, 245
 - parser
 - pointerless, 222
 - vector-stack, 201
 - parser construction, 183
 - ELR*(*k*)
 - grammar, 245
 - language, 245
 - relation with *ELR*(1), 245
 - Empty string, 9
 - Encryption, 298
 - End mark, 305
 - Engelfriet, 351
 - Environment, 361
 - Epsilon move, 105
 - Equations of unilinear grammar, 71, 72
 - Equivalence
 - of finite automata, 98, 103
 - of grammars
 - generalized structural, 56
 - strong, 55
 - weak, 55
 - Equivalent regular expressions, 21
 - Error
 - dynamic, 284
 - objective, 284
 - recovery, 286, 287
 - panic mode, 287
 - panic mode with token insertion, 288
 - semantic, 285
 - state, 98
 - static, 284
 - subjective, 284
 - syntactic, 285
 - treatment, 284
 - type, 284
 - Expansion of nonterminal, 56
 - Extended regular expression, 132, 135
 - External attribute, 342
- F**
- FIN* family, 19
 - Finals, 121
 - Finite
 - automaton, 96
 - deterministic, 97
 - left-linear grammar, 112
 - transducer, 328, 329
 - opposite passes, 331
 - with look-ahead, 332
 - Finite-state family, 109
 - Flex, 332
 - Floyd, 158
 - Operator Precedence languages, 274
 - Follow set, *see* Set of followers
 - Followers, *see* Set of followers
 - Formal language, 5
 - Free monoid, 14
 - Front-end compiler, 364
- G**
- General
 - automaton, 93
 - parser, 248
 - Generalized automaton, 113
 - Goal-oriented, *see* Predictive
 - Grammar
 - ambiguity, 46
 - ambiguity from ambiguous r.e., 68
 - attribute, 335
 - BNF*, 31, 206
 - Chomsky classification, 86
 - clean, 35
 - cleaning, 35
 - context-free, 29
 - context-sensitive, 86
 - EBNF*, 82, 165
 - equivalent, 35
 - errors, 35
 - extended context-free, 82, 165
 - homogeneous, 33, 64

- Grammar (*cont.*)
 - invertible, 59
 - left-linear, 69
 - linear, 68
 - marked *BNF* grammar rule, 169
 - normal form, 33, 56
 - not left-recursive, 63
 - of regular language, 67
 - of Van Wijngarten, 89
 - operator, 62
 - parenthesized, 43, 161
 - representations, 32
 - right linearized, 171
 - right-linear, 69, 103
 - simple deterministic, 161, 242
 - strictly unilinear, 70
 - target, 299
 - translation, 298, 307
 - type 0, 86
 - type 1, 86
 - type 2, 86
 - type 3, 69, 86
 - unilinear, 69
- Graph
 - context-sensitive, 87
 - dependence, 339
 - local automaton, 122
 - parser control-flow, 226
 - pilot, 183
 - program control-flow, 370
 - reachability, 36
 - sibling, 348
 - state-transition, 96
 - syntax chart, 169
 - syntax tree, 38
- Greibach normal form, 33, 65, 152
- Guide
 - predicate, 367
 - set, 227, 232
- H**
- Handle, 176, 190
- Hierarchical list, 27
- Hierarchy of Chomsky, 86
- Homomorphism
 - alphabetic, 79
 - nonalphabetical, 80
- I**
- Incremental
 - compilation, 289
 - parser, 289
- Infix operator, 301
- Inherent ambiguity, 53, 119, 160
- Inherited attribute, *see* Right attribute
- Initial of a string, 10
- Initial state uniqueness, 109
- Initials, *see* Set of initials
- Instruction scheduling, 370
- Interference between variables, 378
- Intermediate
 - language, 364
 - representation, 364, 370
- Internal attribute, 342
- Interprocedural static analysis, 370
- Intersection
 - of context-free and regular language, 153
 - of context-free languages, 79
 - of regular languages, 133, 134
- Intraprocedural static analysis, 370
- Inverse translation, 296
- Invertible grammar, 59
- IO*-automaton, 328
 - sequential, 329
- Item, *see* Candidate
- J**
- JavaScript Object Notation, 272
- JFLAP*, 152
- JSON*, 272
- Jumps, 365
- K**
- Kernel
 - equivalent macro-states, 184
 - of macro-state, 183
- Knuth, 176, 197, 211, 244
- L**
- L* condition for attribute evaluation, 354
- Language, 8
 - abstraction, 24
 - artificial, 5
 - complement, 13
 - context free, 29, 86, 151
 - context sensitive, 87
 - context-free, 35
 - context-sensitive, 86
 - decidable, 95
 - Dyck, 42
 - empty, 8
 - equation, 71
 - finite, 8
 - formal, 5
 - formalized, 5
 - generated, 34
 - infinite, 8
 - recursive derivations, 37
 - local, 122

- Language (*cont.*)
 - locally testable, 122
 - nullable, 10
 - recursive, 95
 - recursively enumerable, 95
 - regular, 19
 - replica, 77
 - with center, 88
 - source, 296
 - substitution of, 26
 - target, 81, 296
 - unary alphabet, 75
 - universal, 13
 - with three equal powers, 76, 87
 - with two equal powers, 73
- Least fixed point, 377
- Left
 - attribute, 338, 341
 - derivation, 41
 - quotient, 17, 210
 - recursive grammar
 - top-down parsing, 214
 - recursive rule, 63
 - elimination, 63
- Left-linear grammar, 69, 112
- Left-recursion, 33
 - elimination, 65
 - immediate, 64
 - $LR(1)$, 211
 - nonimmediate, 64
- Left/right terminal set, 270
- Leftmost derivation, *see* Left derivation
- Length of string, 8
- Levenshtein distance, 286
- Lex, 332
- Lexeme, 352
- Lexical
 - analysis, 352
 - attribute, 342, 353, 354
 - class, 352, 353
 - closed and open, 353
 - finite and non-, 353
 - level, 352
 - segmentation, 353
- Linear
 - grammar, 68
 - language equation, 71
 - regular expression, 124
- Linguistic abstraction, 24
- List
 - abstract, 25
 - concrete, 25
 - hierarchical, 27
 - with precedence, 27
 - with separators, 25
- Live variable, 374, 383
- Live-in, 375
- Live-out, 375
- Liveness, 374, 376, 378
 - equations, 376
 - interval, 373, 375
- $LL(1)$
 - grammar, 242
 - relation with $LR(1)$, 243
- $LL(2)$ example, 240
- $LL(k)$
 - grammar, 244
 - relation with $LR(k)$, 244
- Local
 - automaton, 123
 - normalized, 123
 - language, 122, 136, 372
 - automaton, 122
 - composition of, 123
 - set, 125
 - regular expression, 125
 - testability, 122
- Locally testable language, 136
- Longest prefix rule, 353
- Look-ahead
 - extending, 205
 - increasing, 240
 - set, 174
- $LR(1)$
 - family, 244
 - grammar, 244
 - grammar transformation, 205, 208
 - parser
 - relation with $ELR(1)$, 197
 - superfluous features, 201
 - relation with DET , 244
- $LR(2)$ to $LR(1)$, 207, 208
- $LR(k)$
 - early scanning, 207
 - grammar, 206
 - left quotient, 210
 - transformation, 211
- Lukasiewicz, 302
- M**
- M-state, *see* Macro-state
- Machine net, 165
- Macro-state, 182
 - base, 183
 - closure, 183
 - kernel, 183
- Marked BNF grammar rule, 169, 207, 208
- McNaughton, 137

Meaning, 334
Memory allocation, 378
Metagrammar, 31
Metalanguage of regular expression, 30
Minimal automaton, 100
Minimization of automaton, 101
Mirror reflection, 10
Mixfix operator, 301
Multi-sweep semantic evaluator, 351
Multiple transition property, 184

N

Nerode relation, 101
Nested structure, 29
Network of finite machines, 165
Nivat theorem, 326
Non-deterministic
 union, 158
Non- $LR(k)$, 211
Noncounting language, 136
Nondeterminism motivation, 105
Nondeterministic
 automaton conversion to deterministic,
 114, 130
 finite automaton, 104, 107, 109
 pushdown automaton, 143, 144
Nonnullable normal form, 57
Nonterminal, 30
 alphabet, 31
 expansion, 56
 shift, 179
 in Earley parser, 251
Normal form
 Chomsky, 61
 copy-free, 57
 Greibach, 65
 nonnullable, 57
 real-time, 65
 without repeated right parts, 59
Normalized local automaton, 123
Not left-recursive grammar, 63
Nullable
 language, 10
 nonterminal, 57
 regular expression, 126
Numbered regular expression, 126

O

OAG, 351
On line machine, 150
One-sweep
 attribute evaluation, 347
 attribute grammar, 348
 semantic evaluator construction, 349

Opening mark, 25

Operator

 binary, 301
 degree, 301
 infix, 301
 mixfix, 301
 postfix, 301
 prefix, 301
 unary, 301
 variadic, 301

Operator grammar, 62
 normal form, 33, 62

Operator precedence

 grammar, 269
 languages, 274
 relation, 269, 271
 sequential parser, 275

Opposite passes, 331

Optimization of program, 295, 370, 379, 383

P

Palindrome, 30, 43, 162, 300
 nondeterminism, 159
 pushdown machine, 148

Panic mode error recovery, 287

Papert, 137

Parallel parser, 268, 281

Parenthesis

 language, 41, 161
 redundant, 304

Parenthesized

 expression, 40
 grammar, 43, 161
 tree, 40, 261

Parser, 162

 choice criteria, 246
 Coke–Younger–Kasami, 247
 Earley, 252
 general, 248
 local, 268, 269
 parallel, 268, 277, 281
 predictive, 236, 237
 recursive descent, 238, 239
 semantics-directed, 248, 366
 top-down and bottom-up, 163
 top-down deterministic, 237
 with attribute evaluation, 352
 with attribute evaluator, 355
 with translation, 311

Parser control-flow graph, 226

 direct construction, 232

PCFG, 218, 226

 direct construction, 232

Pilot
 compaction, 218
 construction, 183
 graph, 183
 machine of translator, 314
 Pin, 121
PLZ-SYS, 367
 Pointerless *ELR*(1) parser, 222
 Polish notation, 48, 300, 302
 Portability of compiler, 364
 Postaccessible state, 99
 Postfix
 normal form, 315
 operator, 301
 Power
 of language, 12
 of string, 10
 Powerset construction, 117
 Precedence
 of operators, 11
 relation, 269
 Prediction in Earley parser, 250
 Predictive
 parser, 236
 direct construction, 231
 parser automaton, 237
 pushdown automaton, 143
 pushdown transducer, 308
 Prefix, 10
 operator, 301
 Prefix-free language, 11
 Product
 machine, 134
 of automata, 134
 Production, 31
 Program
 analysis, 369
 optimization, 295, 370, 379, 383
 Projection, 80
 Prospect set, 226, 232
 Pumping property, 73
 Pure syntactic translation, 298
 Pushdown automaton, 95, 142, 143, 146, 151
 accepting modes, 149
 conversion to grammar, 151
 definition, 146
 determinism, 155
 deterministic subclasses, 160
 forms of non-determinism, 155
 time complexity, 146
 Pushdown IO-automaton, 305
 Pushdown transducer, 305, 307, 310
 from translation grammar, 307
 nondeterministic, 310

Q

Quotient
 of grammars, 210
 of languages, 16

R

Rabin and Scott, 323
 machine, 323
 Rational translation, *see* Regular translation
 Reachable
 nonterminal, 35
 state, 99
 Reaching definition, 380, 383
 always, 385
 Real-time normal form, 65
 Recognition algorithm, 92
 Recognize, *see* Accept
 Recursion bilateral, 47
 Recursive
 derivation, 37
 descent, 354
 parser, 213, 238, 239
 parser with attributes, 354
 translator, 311
 machine net, 165
 semantic evaluator, 350
 Reduce move, 176
 Reduce–reduce conflict, 182, 185, 206
 Reduce–shift conflict, *see* Shift–reduce conflict
 Reflection, 10
 of context-free language, 45, 78
 of language, 11
 recognizer of, 106
REG family, 19, 68, 74, 78, 82
 closure properties, 23
 included in *CF*, 68
 Register assignment, 378
 Regular expression, 17
 ambiguity, 21, 68, 69
 extended, 22, 135
 from automaton, 112
 language defined, 21
 linear, 124
 metalanguage, 30
 nullability, 126
 numbered, 22, 126
 Thompson method, 119
 with complement, 132
 with intersection, 132
 Regular expression to automaton, 119
 Berry and Sethi, 129
 structural method, 119
 Thompson, 119

- Regular language, 19
 - intersection, 133
 - pumping property, 73
- Regular translation, 321
 - expression, 323
- Repeated right parts, 59
- Replica, 77, 88
- Reps, 338
- Retargeting, 364
- Reversal as translation, 299
- Right
 - attribute, 338, 340, 341, 357
 - derivation, 41
- Right-linear grammar, 69, 103
- Right-linearized grammar, 200, 237
- Right-recursion, 33
 - $LR(1)$, 211
- Rightmost derivation, *see* Right derivation
- Roger, 152
- Rule
 - Chomsky normal, 33
 - copy, 33, 57
 - empty, 33
 - Greibach normal, 33
 - homogeneous, 33
 - homogeneous binary, 61
 - left-linear, 33
 - left-recursive, 33
 - linear, 33
 - recursive, 33
 - right-linear, 33
 - right-recursive, 33
 - subcategorization, 33
 - terminal, 33
 - with operators, 33
- Run-time error, 364
- S**
 - Sakarovich, 113, 134, 295
 - Scan in Earley parser, 250
 - Scanner, 352
 - Scheduling of instructions, 370
 - Searching a text for a word, 107
 - Self-nested derivation, 74
 - Self-nesting, 42
 - Semantic
 - analysis, 335
 - attribute, 334, 338
 - lexical, 353
 - check, 361
 - error, 361
 - evaluator, 335, 347
 - multi-sweep, 351
 - one-sweep, 347
 - recursive, 350
 - function, 336, 341
 - interpretation, 55
 - metalanguage, 334, 341
 - predicate, 361
 - procedure, 350
 - rule, 336
 - translation, 333
 - Semantics, 5, 293, 333, 334
 - Semantics-directed parser, 248, 366
 - Sentence, 8
 - ambiguous, 21
 - Sentential form, 34
 - Sequential
 - function, 330
 - transducer, 329
 - Set
 - of followers, 129, 173
 - of initials, 121, 174
 - Set operations, 13
 - Sethi, 129
 - Shift
 - move, 176
 - terminal or nonterminal, 182
 - Shift-reduce
 - conflict, 182, 185, 208
 - parser with attribute evaluator, 357
 - translator, 313
 - Sibling graph, 348
 - Simple deterministic grammar, 161, 242
 - Single-transition property, 214, 218
 - Single-valued translation, 305
 - Sink state, *see* Trap state
 - Skeleton tree, 40
 - condensed, 40
 - Sms, 190
 - Source
 - grammar, 299
 - ambiguity, 305
 - language, 296
 - Spontaneous loop in pushdown machine, 150
 - Spontaneous move, 105, 109, 147
 - elimination, 114, 115
 - Stack
 - candidate, 190
 - m-state, 190
 - macro-state, 190
 - Star
 - of context-free language, 44, 78
 - operation, 14
 - properties, 15
 - Star-free language, 136
 - State
 - accessible, 99

- State (*cont.*)
 - distinguishable, 100
 - postaccessible, 99
 - reachable, 99
 - trap, 98
 - useful, 99
 - useless, 99
- State-transition diagram, 96
 - pushdown machine, 148
- Static error, 361
- Static program analysis, 364, 369, 387
 - interprocedural, 370
 - intraprocedural, 370
- STP*, *see* Single-transition property
- Strictly unilinear grammar, 70
- String, 8
 - empty, 9
- String form, 34
- Strong equivalence of grammars, 55
- Structural adequacy, 55, 70
- Subcategorization rule, 57
- Subjacent automaton, 325, 328, 330, 332
 - pushdown, 306
- Substitution, 26, 81
 - closure property, 81
- Substring, 10
- Suffix, 10
- Symbol table, 285, 361
- Syntactic
 - analysis, 162
 - error, 285
 - level, 352
 - procedure, 212, 238
 - semantic analyzer, 355
 - support, 336, 341
 - translation, 298
 - translation scheme, 299
- Syntactic-semantic analysis, 352
- Syntax, 5
 - abstract, 24
 - analysis, 162
 - bottom-up and top-down, 163
 - chart, 169, 372
 - tree, 38
 - abstract, 303, 335
 - as translation, 319
- Syntax-directed
 - compiler, 334
 - translation, 121, 299, 334
- Synthesized attribute, *see* Left attribute
- T**
- Target
 - grammar, 299
 - language, 81, 296
- Terminal
 - alphabet, 31
 - shift in Earley parser, 250
 - symbol, 7
- Thompson, 119
- Token, 352
- TOL*, 349
- Tomita, 248
- Top-down
 - deterministic translation, 311
 - parsing, 211
 - syntax analysis, 163
- Topological sort, 346
- TOR*, 349
- TOS*, 349
- Transition networks, 169
- Translation
 - closure properties, 332
 - function, 296, 297, 330
 - sequential, 330
 - grammar, 298, 307, 327
 - EBNF*, 313
 - postfix normal form, 315
 - rule normalization, 307
 - to pushdown transducer, 307
 - rational, *see* Regular translation
 - regular, *see* Regular translation
 - relation, 296
 - scheme, 299
 - single-valued, 305
 - syntactic, 298
- Translator
 - bottom-up, 313
 - comparison, 320
 - top-down, 311
 - two-way, 331
 - with recursive procedures, 311
- Transliteration, 79, 298
 - to words, 80
- Trap state, 98
- Tree
 - construction, 261
 - decorated, 337
 - syntax, 38
- Tree pattern matching, 364
- Turing machine, 86, 95
- Two-input automaton, 323, 324
- Two-pass compiler, 335
- Type 0 grammar, 86
- Type 1 grammar, 86
- Type 2 grammar, 86
- Type 3 grammar, 69, 86
- Type checking, 361

U

Unary

- alphabet, 75
- operator, 301

Undecidability

- deterministic context-free language, 245
- deterministic pushdown automaton, 245
- $LR(k)$, 245

Undistinguishability of states, 101

Unilinear grammar, 69, 110

- equations, 71

Uninitialized variable, 386

Union of context-free languages, 43, 78

Universal language, 13, 14

Unreachable code, 373, 384

Useful state, 99

Useless

- assignment, 374
- state, 99
 - elimination, 99
- variable definition, 379

Uzgalis, 89

V

Van Wijngarten, 89

Variable

- availability, 385
- definition, 371
 - suppressed, 381
- initialization, 385, 386
- use, 371

Variadic operator, 301

Vector-stack parser, 201

Vocabulary, 8

VW grammar, 89

W

Weak equivalence of grammars, 55

Well-defined nonterminal, 35

Word, 8

X

XML, 42, 162

Y

Yang, 332